MEMORANDUM

To: Amy Hambrick, U.S. EPA, Sector Policies and Programs Division/Natural Resources and Commerce Group

From: Eastern Research Group, Inc.

Date: January 2011

Subject: Revised Estimation of Baseline Emissions from Existing Sewage Sludge Incineration Units

---

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), under section 129 of the Clean Air Act (CAA), is required to regulate emissions of nine pollutants from sewage sludge incineration (SSI) units: hydrogen chloride (HCl), carbon monoxide (CO), lead (Pb), cadmium (Cd), mercury (Hg), particulate matter (PM), total mass basis dioxins/furans (TMB PCDD/PCDF) and toxic equivalency basis dioxin/furans(TEQ PCDD/PCDF), nitrogen oxides (NO_x), and sulfur dioxide (SO_2). In order to assess the effects of regulatory requirements on these pollutants, it is first necessary to determine their emissions at the current level of control at each SSI unit. These emissions are referred to as the baseline emissions.

This memorandum describes the development of baseline emissions estimates for existing sources in the SSI source category. Section 2.0 discusses the sources of data used in the development of the baseline emission estimates, Section 3.0 presents the methodology used to estimate baseline emissions, and Section 4.0 summarizes the results of this analysis. Tables 1-1 and 1-2 summarize the baseline emissions estimated for the nine section 129 pollutants regulated by SSI emission guidelines for existing sources in two subcategories, multiple hearth (MH) incinerators, and fluidized bed (FB) incinerators. Table 1-1 presents 'actual' emissions, based on dry sludge feed rates reported by facilities and additional extrapolated data. Table 1-2 presents 'potential' emissions, based on known dry sludge design capacities and additional extrapolated data. Unit design capacities and average feed rates are discussed in detail in the database revisions memorandum.[1]

Table 1-1. Summary of Baseline Emissions for Existing SSI Units (tons per year) – Based on Actual Dry Sludge Usage

Sub-category	Cd	Pb	Hg	HCl	SO_2	NO_x	CO	PM	PCDD/PCDF (mass)	PCDD/PCDF (TEQ)
FB	0.0015	0.0056	0.039	1.59	42.6	316	73	24.9	0.0000007	0.00000006
MH	0.91	2.37	0.855	26.6	660	2,060	8,430	308	0.0000056	0.00000038
Total	**0.91**	**2.37**	**0.894**	**28.2**	**702**	**2,380**	**8,500**	**333**	**0.0000063**	**0.00000044**

Table 1-2. Summary of Baseline Emissions for Existing SSI Units (tons per year) – Based on Dry Sludge Capacity

Sub-category	Cd	Pb	Hg	HCl	SO_2	NO_x	CO	PM	PCDD/PCDF (mass)	PCDD/PCDF (TEQ)
FB	0.0022	0.0077	0.058	2.17	56.7	476	101	37.2	0.0000010	0.00000008
MH	1.15	3.07	1.15	41.2	1,020	2,800	11,475	408	0.0000076	0.00000051
Total	**1.15**	**3.07**	**1.21**	**43.3**	**1,080**	**3,280**	**11,580**	**445**	**0.0000086**	**0.00000059**

2.0 DATA SOURCES

Emissions information on SSI units was collected from two sources. An information collection request (ICR) survey was sent to nine owners of SSI's units, who provided characterization information (costs, controls, operating information) for their units.[2] The survey respondents also provided emissions test data from 16 SSI units. Some of the tests were conducted in response to the ICR; other test reports were for tests conducted within five years prior to the ICR request. A second source of emissions information was test reports collected from State environmental agencies' public databases for nine SSI units (all MH units). The emission tests in these reports were conducted between 2000 and 2009. The emissions information and ICR responses are further discussed in the memorandum, "Facility, Unit, and Emissions Test Database for the Sewage Sludge Incineration Source Category".[3]

Baseline emissions were calculated for 204 SSI units, of which 144 have the MH combustor design and 60 have the FB combustor design. As indicated above, emissions information was gathered on 26 SSI units (20 MH and 6 FB units). The information in the emissions test reports were then applied to the other SSI units based on their characteristics and controls. The revised inventory of SSI units is discussed in the database revisions memorandum.[1]

3.0 METHODOLOGY FOR ESTIMATING BASELINE EMISSIONS

All the emissions information collected were for stack tests conducted following all the control devices, i.e., controlled emissions at the baseline level of control. For units where emissions information was gathered, the average concentration of the individual test runs was used to calculate their baseline emissions. If multiple tests were conducted for a unit, then the average was calculated as the average of all the test runs. Baseline emissions on an annual basis were calculated from the concentration reported in the test information corrected to 7 percent oxygen (either parts per million volume dry (ppmvd), milligrams per dry standard cubic meter (mg/dscm), or nanograms per dry standard cubic meter (ng/dscm), the flue gas flow rate of the emission stream corrected to 7 percent oxygen in dry standard cubic feet per minute (dscfm), and the hours of operation of the unit. Attachment A shows the calculations used for converting concentration values to emission rates.

For the remaining units where emissions information was not available, baseline emissions were calculated using average concentrations, flow rates, and hours of operation. The development and use of these parameters is discussed in this section.

3.1 Assignment of Concentrations

In order to calculate baseline emissions for all units, an average concentration was calculated from the known information and assigned to the remaining units without data. Slightly different approaches were taken for each subcategory, as described below. Table 3-1 presents the assumed baseline concentrations for each pollutant for each unit.

MH Units:

First, the uncontrolled average concentration for each unit with test data was calculated using the following equation:

$$\text{Uncontrolled Concentration} = (\text{Controlled Concentration}) \div [1- (\%\ \text{control efficiency}/100)]$$

The control efficiencies used in the calculation are presented in Table 3-2. The efficiencies were based on assumptions used in previous EPA regulations, particularly the industrial, commercial, and institutional boiler NESHAP, and incorporate engineering judgment based on information provided by EPA testing personnel, internet web searches, and EPA technical documents and fact sheets on control devices.[4-6] For this analysis, whenever there were multiple control devices affecting the same pollutant, the highest reduction efficiency for all the controls was used. For example, if a unit had a venturi scrubber and a fabric filter, the control efficiency of the fabric filter for cadmium and lead control was assigned to the combination because fabric filters are more efficient in controlling these pollutants. While some additional control may be achieved from multiple controls in series, most of the controls currently used at SSI units do not generally overlap in their effectiveness for most pollutants. The assumption also provides the most conservative estimate of performance. Although some units use thermal oxidizers or afterburners and achieve lower CO emissions levels, reduction efficiency was not assigned to them for CO because data were not available to determine a percent reduction value. For these units, the baseline level of CO emissions will be overstated. FGR has been used on combustion devices to reduce NO_x emissions. However, the amount of NO_x reduced varies widely, ranging from 20 percent to 80 percent, and site-specific factors often affect the performance. Emissions test data collected by EPA showed that one unit providing emission test data operates a MH unit with FGR. However, its emission levels are similar to units without FGR. So no conclusion could be made on FGR performance. For CO, NO_x, and PCDD/PCDF, the average of emissions from all 5 tested MH units were applied, because emissions of these pollutants are influenced more by the combustion mechanism of MH units rather than add-on control device technologies used at MH units.

Once all concentration data were converted to uncontrolled levels, all the uncontrolled data points for a pollutant in a subcategory were averaged to develop average uncontrolled concentration levels. The average uncontrolled levels developed for each pollutant were then used to estimate emissions after application of existing controls (referred to as baseline emissions) for each SSI unit without emissions data by applying the pollutant control efficiencies (from Table 3-2) for the control devices currently in use (as identified in the SSI inventory database). The following equation was used:

Baseline Concentration = (Uncontrolled Concentration) x [1-(% control efficiency/100)]

FB Units:

Four of the six FB units with emissions data have wet electrostatic precipitators in addition to venturi and impingement tray scrubbers. For Cd, Pb, Hg, and PM, emissions from these units were averaged, and that average was applied directly to other units having WESPs. For other units not having WESPs as part of their controls, the Cd, Pb, Hg, and PM emissions values from the FB with the most basic controls (venturi scrubbers and impingement tray scrubbers) were considered indicative of the emission levels achieved with these scrubbers, and were assigned to units with these controls.

For CO, NO_x, and PCDD/PCDF, the average of emissions from all tested FB units were applied, because emissions of these pollutants are influenced more by the combustion mechanism of FB units rather than add-on control device technologies used at FB units.

For HCl and SO_2, the same back-calculation method used for the MH subcategory was applied to fill data gaps.

3.2 Determining Flow Rates

The flue gas flow rate exiting the SSI units where data were not available was extrapolated using the linear regression relating known flue gas flow rates to the dry tons of sludge fired. Two feed rates were considered to show the range of potential emissions. The first was the average sludge feed rate based on information provided by sources. The second was the emissions based on the unit design capacity. We estimated the design capacity emissions because the amount of wastewater treated (and sludge produced) may vary significantly based on changes in population or sources of wastewater. Facilities have the potential to burn up to their units permitted capacity although they may not be doing so currently. Once flow rates were determined, they were adjusted to 7% O_2, using average reported O_2 values for each subcategory. More information about how unit capacity values, average feed rates, and average and maximum flow rates were developed can be found in the database revisions memorandum.[1]

3.3 Development of Default Operating Hours

For some of the surveyed SSI units, the operating time was provided.[2] Additionally, some operational hours were provided during the post-proposal comment period. Known operational hours were averaged based on the number of units at each facility, and these averages were then applied to fill in data gaps for this parameter. For instance, the average number of hours reported for facilities having only 1 unit was 5,004 hrs/yr. This value was applied to all units operating at facilities with just the one unit. Further details on how operational hours were assigned to units with no data can be found in the database revisions memorandum.[1]

4.0 SUMMARY OF RESULTS

Table 4-1 presents the ‘actual’ baseline concentrations and calculated emissions for each pollutant and at each SSI unit. Table 4-2 presents the ‘potential’ baseline concentrations and calculated emissions for each pollutant and at each SSI unit. Flue gas flow rates and operating hours assigned for each SSI unit are also listed in these tables.

5.0 REFERENCES

1. Post-Proposal SSI Database Revisions and Data Gap Filling Methodology. Memorandum from Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. January 2011.

2. Facility, Unit, and Emissions Test Database for the Sewage Sludge Incineration Source Category. Memorandum from Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. June 2010.

3. Inventory Database for the Sewage Sludge Incineration Source Category. Memorandum from Eastern Research Group to Amy Hambrick, U.S. Environmental Protection Agency. June 2010.

4. Development of Baseline Emission Factors for Boilers and Process Heaters at Commercial, Industrial, and Institutional Facilities. Memorandum from Amanda Singleton and Graham Gibson, Eastern Research Group to Jim Eddinger, U.S. EPA. April 2010.

5. Technology Transfer Network, Clean Air Technology Center. http://www.epa.gov/ttn/catc/products.html

6. A Comparison of Fluid Bed and Multiple Hearth Biosolids Incineration. Ky Dangtran, John Mullen, and Dale Mayrose. Paper presented at the 14th Annual Residuals and Sludge Management Conference. February 27-March 1, 2000, Boston MA

Attachment A

Conversion of Units

The following calculations were used to develop ton/year emission estimates:

PM, Pb, Cd and Hg

Concentration "X" given in mg/dscm, flow rate "FR" in dscf/minute (dscfm), and annual hours "H" (hours/year):

[X(mg/dscm) x FR(dscf/min) x 60(min/hr) x H(hr/year)] ÷
[35.3147(dscf/dscm) x 453,592(mg/lb) x 2,000(lb/ton)] = (ton/yr)

PCDD/PCDF

Concentration "X" given in ng/dscm, flow rate "FR" in dscf/minute (dscfm), and annual hours "H" (hours/year):

[X(ng/dscm) x FR(dscf/min) x 60(min/hr) x H(hr/year)] ÷
[35.3147(dscf/dscm) x 1,000,000 (ng/mg) x 453,592(mg/lb) x 2,000(lb/ton)] = (ton/yr)

HCl, NO_x, SO_2, CO

Concentration "X" given in ppmvd, flow rate "FR" in dscf/minute (dscfm), annual hours "H" (hours/year), and molecular weight "MW" as follows: HCl = 36.45, NO_x = 46, SO2 = 64.06, CO = 28.01:

[X(ppmvd) x MW(lb/lbmol) x FR(dscf/min) x 60(min/hr) x H(hr/year)] ÷
[1,000,000 x 385.5(dscf/lbmol) x 2,000(lb/ton)] = (ton/yr)

Tables 3-1 through 4-2

See BaselineEmissionsMemo_Table3-1to4-2.xlsx